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Geometric Mechanics and Structure Preserving Discretizations of Shell Elasticity

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Combining (discrete) differential geometry with finite elements to develop structure preserving numerical methods for continuum mechanics (shell elasticity)

Continuum mechanic problems arise in a vast variety of technology in industry. Fast, robust, and reliable discretization methods are desirable to simulate elasticity applications. It is well-known that linear Lagrangian finite elements perform badly in several elasticity regimes and a huge amount of effort has been invested since decades developing improved procedures.

In this talk we present mixed finite elements for (non-)linear elasticity including the tangential-displacement normal-normal-stress continuous (TDNNS) method by including the stress and strain fields as additional unknown fields, discretized by suitable matrix-valued elements. Their excellent performance in the nearly incompressible regime and for anisotropic structures is demonstrated and discussed. Further, simple and locking-free plate and shell elements are proposed relying on mixed Hellan-Herrmann-Johnson and TDNNS methods.

We present several numerical examples implemented in the open-source finite element software NGSolve (www.ngsolve.org).

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